



January 2026
Study of Physical Data Gaps to Inform the Implementation
of Nur Rematriation Upstream of Shasta Dam
(AB 211 Drought Grant Agreement Number – Q2396040)



Appendix F

Physical Considerations for Construction of a Volitional Swimway around Keswick and Shasta Dams

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ATTACHMENTS

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ABBREVIATIONS

Background Compendium	<i>Background Compendium and Design Criteria Report for the Feasibility of Volitional Fish Passage Above Keswick and Shasta Dams</i>
CDFW	California Department of Fish and Wildlife
CEC	California Energy Commission
CA	California
Consultant Team	Anchor QEA, HDR Engineering, Inc., U.S. Geological Survey and QEDA Consulting, LLC
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HDR	HDR Engineering, Inc.
LiDAR	Light Detection and Ranging Data
LFA	limiting factors analysis
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
Nomtipom Waywaket	Winnemem Wintu words for Sacramento River
Nur	Winnemem Wintu word for Chinook Salmon
OHW	Ordinary High Water
QEDA	QEDA Consulting, LLC
SFHA	Special Flood Hazard Area
SF	Square feet
Study streams	Cow Creek, Little Cow Creek, Dry Creek, McCloud River
US	United States
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
Winnemem Waywaket	Winnemem Wintu words for McCloud River

1 Introduction

A team of engineering and fisheries science consultants consisting of Anchor QEA; HDR Engineering, Inc. (HDR); U.S. Geological Survey (USGS); and QEDA Consulting, LLC (QEDA) known herein as the “Consultant Team,” has received funding from the California Department of Fish and Wildlife (CDFW) to implement studies to gather data, compile information, and identify data gaps related to physical and biological conditions in the Study Area. These studies will be referred to within this document as the “Project.” The results of the Project will support an investigation of the feasibility of providing volitional passage for fish, particularly Chinook Salmon (*Oncorhynchus tshawytscha*), above Keswick and Shasta dams on the Nomtipom Waywaket (also known as the Sacramento River) and into the Winnemem Waywaket (also known as the McCloud River) in northern California. In this document, Chinook Salmon is used to generally describe the species because once connectivity is re-established through reintroduction, fish will adapt to the new environments and could display run timing consistent with multiple runs. It is inclusive of Nur, which the Winnemem Wintu Tribe uses for Chinook Salmon that have been raised by the Tribe. The formal, Evolutionarily Significant Unit (ESU)-specific name (e.g., Sacramento River winter-run Chinook Salmon) is used when discussing federal Endangered Species Act (ESA)-listed Chinook Salmon or steelhead (*O. mykiss*). This document is an appendix to the overarching report documenting the results of the Project, which is called the *Background Compendium and Design Criteria Report for the Feasibility of Volitional Fish Passage Above Keswick and Shasta Dams* (Background Compendium). This larger report contains additional background information for the Project and this document should be considered within this context.

The Project Study Area extends from the confluence of Cow Creek and the Nomtipom Waywaket and includes the Winnemem Waywaket from Shasta Reservoir to the McCloud Dam (Figure 1). It includes portions of the Winnemem Waywaket; the Nomtipom Waywaket, including Keswick and Shasta dams and reservoirs; Cow Creek; Little Cow Creek; and Dry Creek. These water bodies vary in hydrology, geomorphology, and water quality, with seasonal fluctuations in temperature and flow; these parameters are being measured during this Project to evaluate habitat suitability and passage for salmonids. Understanding these physical conditions is essential to evaluating the feasibility of restoring fish passage to historical spawning and rearing areas upstream of the dams.

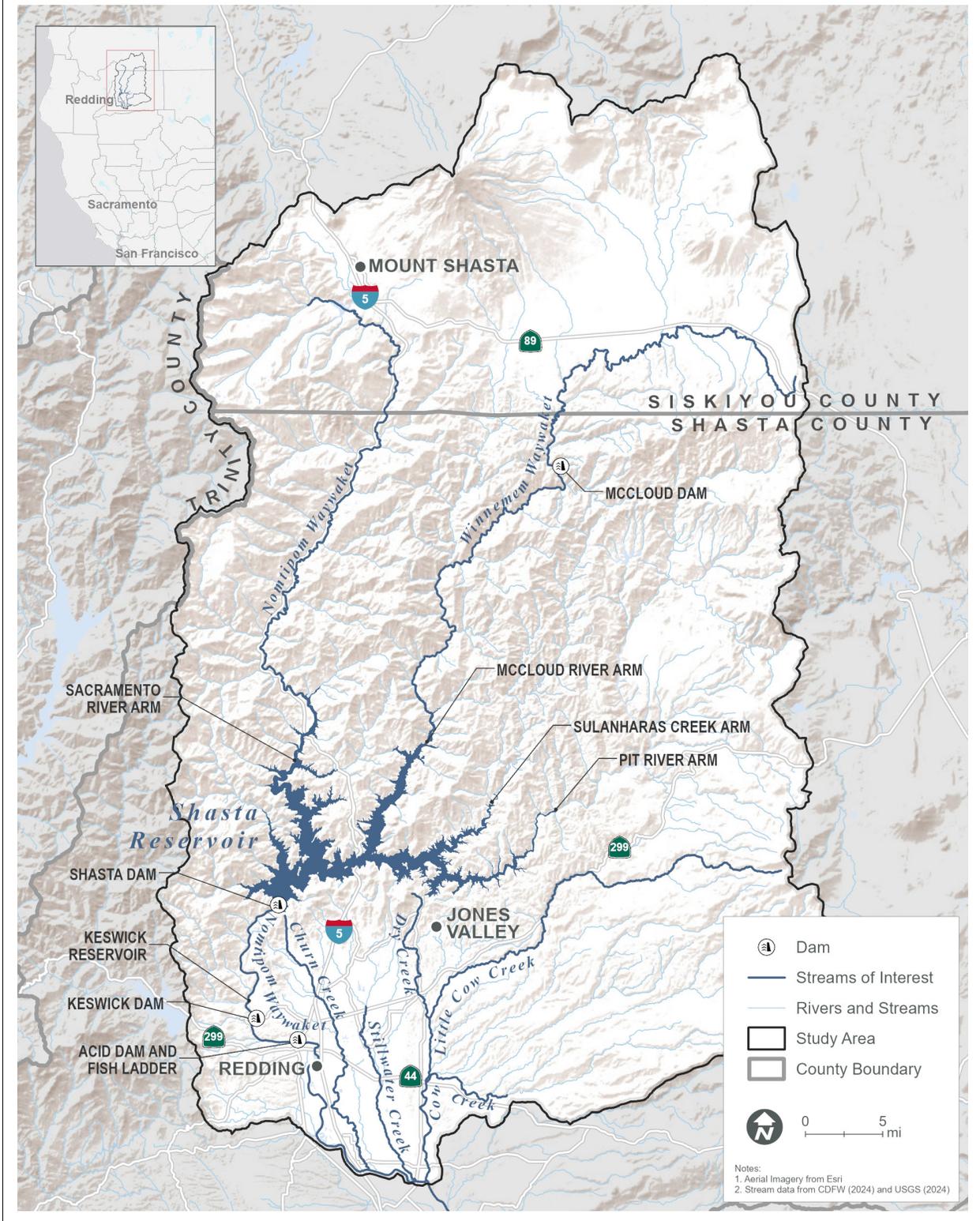
This document provides a summary of existing data within the Study Area that includes topographic data, transportation corridors, electrical service, property ownership and use, and stream access points. The information informs potential limitations for the construction and operation of fish passage facilities within the Study Area. Information collected and compiled during the Project will be used to support a volitional passage feasibility study that will be reviewed by the salmon co-managers (Winnemem Wintu Tribe, CDFW, and National Marine Fisheries Service [NMFS]) and used to inform fish passage decisions.

The objectives of this document are to:

- Synthesize readily available information on topographic data, transportation corridors, electrical service, property ownership and use, Federal Emergency Management Agency (FEMA) flood zone, and stream access points in the Study Area along the Winnemem Waywaket, Dry Creek, Little Cow Creek, and Cow Creek (herein referred to as the study streams).
- Summarize resulting limiting factors on the construction and operation of potential fish passage facilities within the Study Area based on the available information.
- Identify preliminary recommendations and information data gaps that will be used to inform future fish passage facility siting and evaluation.

Readers should understand that on December 12, 2025, the Consultant Team received an email stating that the Winnemem Wintu Tribe does not endorse these reports (referring to the Background Compendium and appendices and *Alternatives Formulation and Evaluation Report* [Anchor QEA and HDR 2026]).

Figure 1
Study Area, Key Features, and Project Vicinity



2 Summary of Existing Data

Data for existing physical conditions were sourced via desktop research and compiled into an online database to be used in the limiting factors analysis (LFA) and to support the development and evaluation of fish passage alternatives. The online database was also used to create figures included in this document. A complete summary of data sources used in this analysis and metadata are included in Attachment A. The North American Vertical Datum of 1988 and the horizontal coordinate system of North American Datum 1983 State Plane California I Federal Information Processing Standards 0401 (United States Feet) was used for each dataset within the online database.

2.1 Data Used within the Limiting Factors Analysis

Data collected and described for the LFA in Sections 2.1.1 through 2.1.6 includes topography, transportation corridors, electrical service areas, parcel data (including property ownership, land use type, and development), and stream access points.

Figure 2 through Figure 7 display the existing data collected within each region of the Study Area used to inform the LFA (Section 3).

2.1.1 *Topographic and Bathymetric Data*

The Consultant Team used the USGS's Light Detection and Ranging Data (LiDAR) Explorer Map (USGS 2024) to determine if LiDAR data existed in the Study Area for study streams and found that one dataset was available. This dataset was collected by the NOAA Office for Coastal Management Partners on behalf of USGS in 2019 and 2020 and is titled the Carr Hirz Delta Fires, CA. The dataset covers approximately 2,342 square miles which span four counties (OCM Partners 2024). The data are Classified LiDAR Aerial Survey 1.4 files used to create intensity images, 3D breaklines, and hydro-flattened digital elevation models using nominal pulse spacing of 0.35 meters. The dataset was collected in fall and winter 2019 when there was no snow on the ground and rivers were at or below normal levels thereby representing bare earth surface.

Bathymetric data was identified only in areas where the study streams were dry at the time of LiDAR collection; the LiDAR captured the water surface elevation rather than channel bathymetry in all areas where there was flow. Examination of the existing LiDAR data allowed the Consultant Team to provide a recommendation for additional LiDAR data collection in the Study Area for more detailed channel bathymetric data (see further discussion of this in Section 4.1).

The topographic LiDAR data will allow the Consultant Team to initiate conceptual design and siting of key landward features of the Project including access roads, lay down areas, and fish passage facilities. The bathymetric LiDAR data will inform the analysis of existing channel elevation and width to identify challenges to volitional passage.

2.1.2 Transportation Corridor Data

Locations of all road types (i.e. city, federal, private) were added to the online database as transportation corridors (Attachment A). All data other than the Forest Service data was collected and attributed in 2012 by the Shasta County Department of Resource Management Planning Division and is regularly updated by Shasta County. Each road was assigned to a functional class based on surface type and included the following: asphalt, asphalt/gravel, chip and seal, concrete, dirt, gravel, gravel/dirt, or other. Basemap imagery was used to identify surface type (Shasta County 2024). National Forest Service roads were added from the United States Department of Agriculture (USDA) Forest Service database; the data was originally published in 2019 and has been updated as recently as 2024 (USDA Forest Service 2024). All the roads within the National Forest Service data were examined and categorized by surface type (i.e. asphalt, crushed aggregate, gravel, compacted soil, native material, Portland cement concrete, etc.), number of lanes, and by its objective maintenance level (i.e. high clearance vehicles, passenger cars, decommissioned, etc.).

Two private roads, the Bollibokka Fly Fishing Club Private Road and the McCloud Fly Fishing Club Private Road, were hand-digitized using aerial imagery from Google maps (HDR 2024a). The extent of drivable roads is unknown and should be assessed via site visits at a later stage of the Project. For the purposes of this evaluation, it is assumed that these roads can be driven by car.

The transportation corridor data will inform the Access factor within the LFA (Section 3.1) for regular staffing, maintenance, or construction activities at different potential fish passage facility locations. At later stages, road surface type may also be utilized to determine condition of existing roads and resulting limitations on the type of vehicles that may be able to traverse the roadways in future Project phases.

2.1.3 Electrical Service Data

Detailed transmission and electrical service linework was obtained from four different sources including the California Energy Commission (CEC), PacifiCorp, City of Shasta Lake, and City of Redding. Data provided by the CEC includes high-voltage transmission lines located within Shasta County (CEC 2024). The data was originally published in 2018 and is updated quarterly with the most recent update occurring in 2024. The data includes capacity, owner, status, and a classification as either overhead, underground, or underwater.

Data provided by PacifiCorp includes local distribution substations, lines, and secondary lines, mostly providing residential power (PacifiCorp 2024). The PacifiCorp service area primarily resides to the north and west of McCloud Dam along Interstate 5 and within the City of Mount Shasta.

The city of Shasta Lake provided data for their electrical service area, which is approximately bounded by the City's limits west of the study streams and is not displayed on the figures (City of Shasta Lake 2024).

The city of Redding data includes overhead and underground primary service, secondary service, and transmission line service. The information is all located within the city limits, west of the study streams and is also not displayed on the figures (City of Redding 2024).

Pacific Gas and Electric Company (PG&E) did not provide detailed electrical service linework for the Study Area; however, based on a review of electric service area maps, PG&E is the main provider of power for the residential homes and public buildings along the study streams (PG&E 2014).

Knowledge of the electrical services in the Study Area will inform the Power Availability factor in the LFA (Section 3.1) by identifying general areas without existing power nearby, thereby increasing the difficulty and cost in constructing and operating a potential fish passage facility.

2.1.4 Parcel Size, Ownership, and Use Data

Parcel data was acquired from Regrid, a property data and location intelligence company that sources its data directly from Shasta County and standardizes the raw data into a table (LOVELAND Technologies 2024). The data is updated periodically and was last updated on August 15, 2023. Parcels within 100 feet of study streams were selected for use in the LFA because a future fish passage facility would require access to the stream. The data includes a full list of attributes for each parcel, including Assessor Parcel Number, parcel size, description of land use, zoning code, zoning description, and owner.

Parcel ownership, use, and parcel size are important for determining the Parcel Type and Parcel Size factors in the LFA (Section 3.1) because they provide insights about anticipated level of difficulty for future efforts to acquire easements and real estate and the number of acquisitions that may be required.

2.1.5 FEMA Flood Zone Data

FEMA has conducted detailed flood studies in Cow Creek, Little Cow Creek, and portions of Dry Creek and the Winnemem Waywaket using the following designations:

- Zone A – a Special Flood Hazard area (SFHA) with a base flood elevation measured by a detailed flood study. The lower region of Cow Creek is Zone A as is a portion of the Winnemem Waywaket, extending to a point just upstream of the McCloud Bridge.
- Zone AE – a SFHA without a base flood elevation. The lower region of Dry Creek, the entirety of Little Cow Creek, and the upper region of Cow Creek is Zone AE.

- Zone X (Unshaded) – an area of minimal flood hazard. The upper region of Dry Creek is Zone X (unshaded).
- Zone D – an area of possible but undetermined flood hazard. Most of the Winnemem Waywaket upstream of the McCloud Bridge is Zone D.

Understanding FEMA Flood Zone type designations will be important for the permitting process. Any fish passage facility will need to connect to the existing stream channel and could cause changes to the water surface elevation. If a facility connects to the stream in a Zone A or AE location, additional permitting analyses may be required (e.g., a Letter of Map Revision to record changes to the base flood elevation mapped by FEMA). A connection to the stream channel in a Zone X (unshaded) location may not require additional permitting analysis, although coordination with the local floodplain administrator will be needed. A facility in a Zone D location may require additional permitting and must be coordinated with the local floodplain administrator.

At this stage of fish passage alternative development, knowledge of the FEMA-identified flood zone within the study streams informs the level of complexity needed for future permitting efforts and the resulting FEMA Flood Zone factor in the LFA (Section 3.1).

2.1.6 Stream Access

For construction and operation of a fish passage facility, vehicles and other heavy machinery will need frequent stream access, which is defined as an existing roadway, crossing, or culvert used for vehicle access to water.

Stream access data was gathered in two ways. First, available aerial imagery was reviewed to locate existing water crossings of the study streams and existing improved or unimproved roadways leading to the approximate location of the stream's Ordinary High Water (OHW) line. The OHW line delineates the maximum water level that occurs during the high flow season for a long enough time to leave evidence on the landscape (e.g., shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris). The aerial imagery was sourced from Google Earth from June 2023, May 2024, November 2023, April 2023, and February 2024 (Google Earth 2024). A pin was placed at each road crossing and at each roadway leading to the OHW line (HDR 2024b). These points were titled Ordinary High Water Access and Stream Crossings. Second, stream access was also identified through field investigations. On November 6 and 7, 2024, members of the Consultant Team performed a site reconnaissance of portions of Little Cow Creek and Dry Creek to document characteristics of several potential fish barriers (HDR 2025). The reconnaissance confirmed the location of several additional water crossings in the form of bridges or culverts, titled Field-Confirmed Stream Crossings, which also identify locations where a vehicle could access the stream.

Figure 2
Existing Physical Data (Winnemem Waywaket, north)

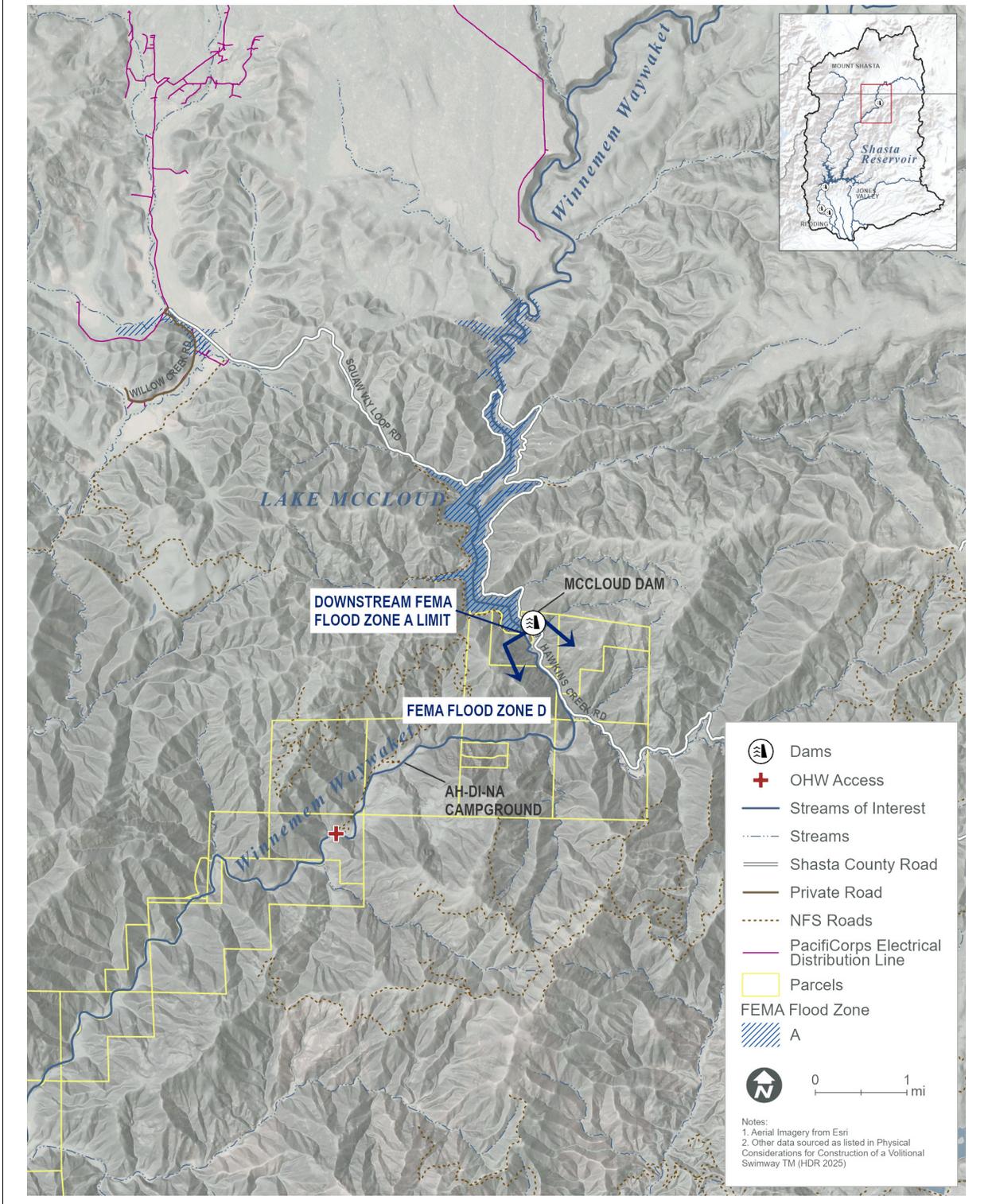


Figure 3
Existing Physical Data (Winnemem Waywaket, south)

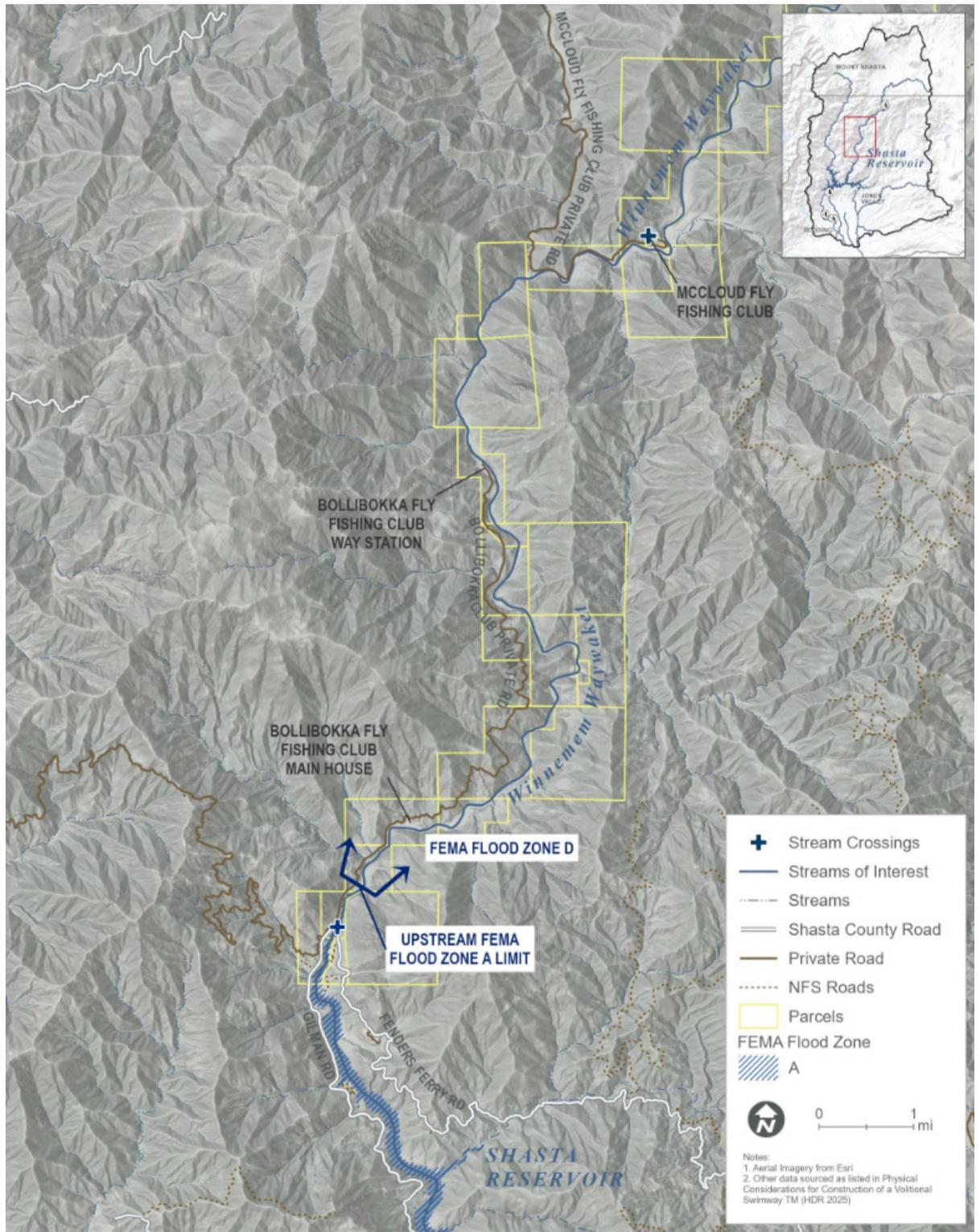


Figure 4
Existing Physical Data (Dry Creek, north)

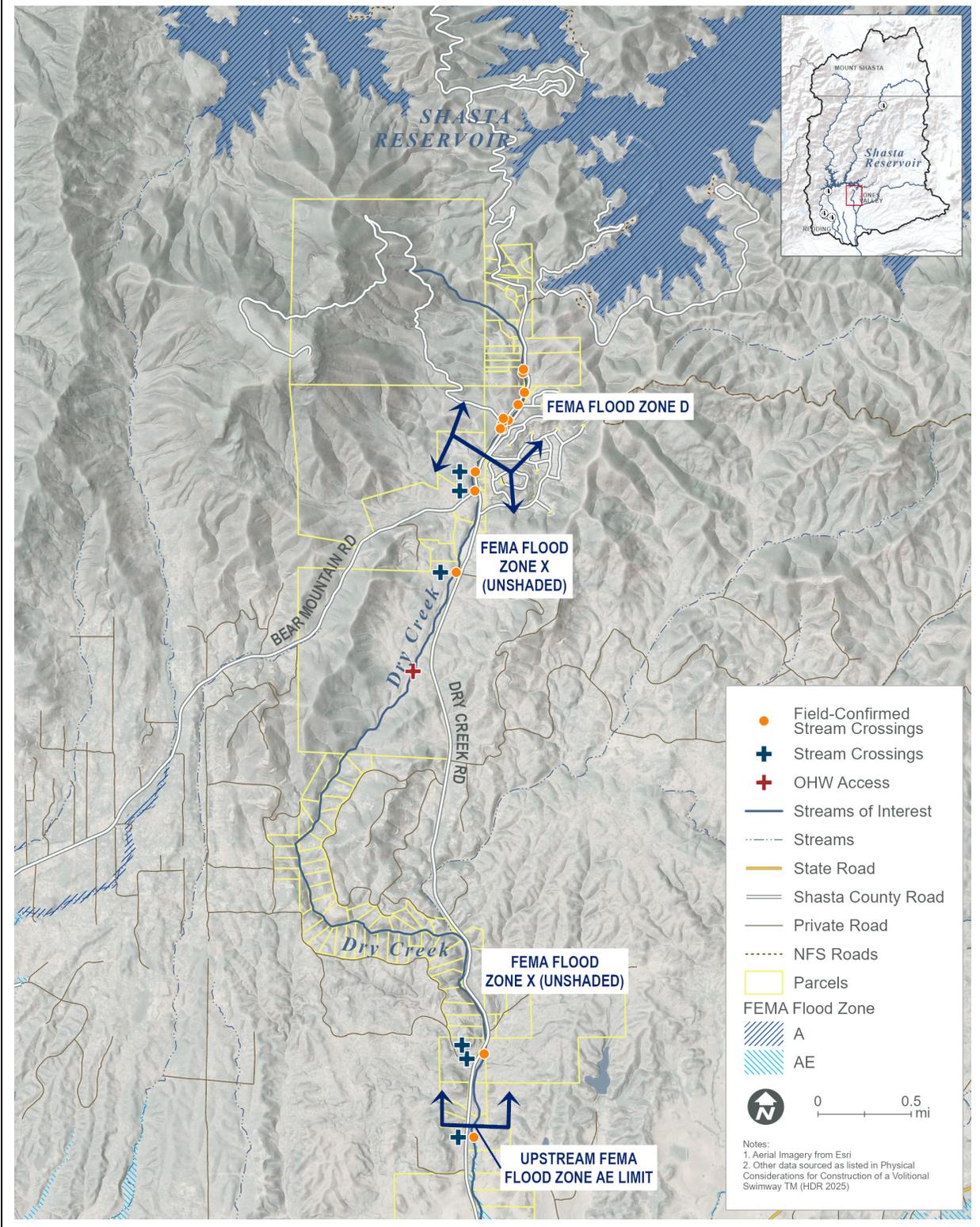


Figure 5
Existing Physical Data (Dry Creek, south and Little Cow Creek, north)

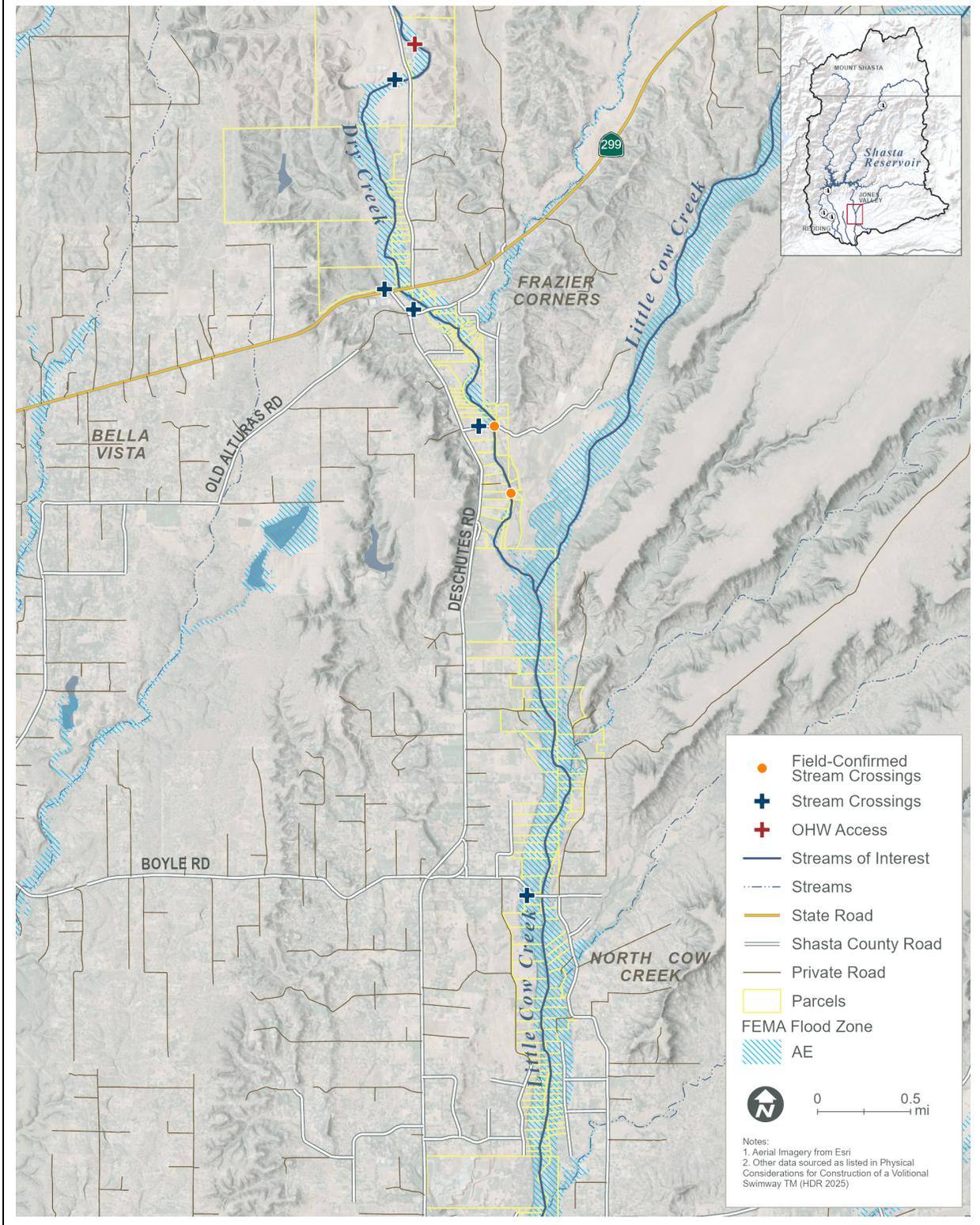


Figure 6
Existing Physical Data (Little Cow Creek, south and Cow Creek, north)

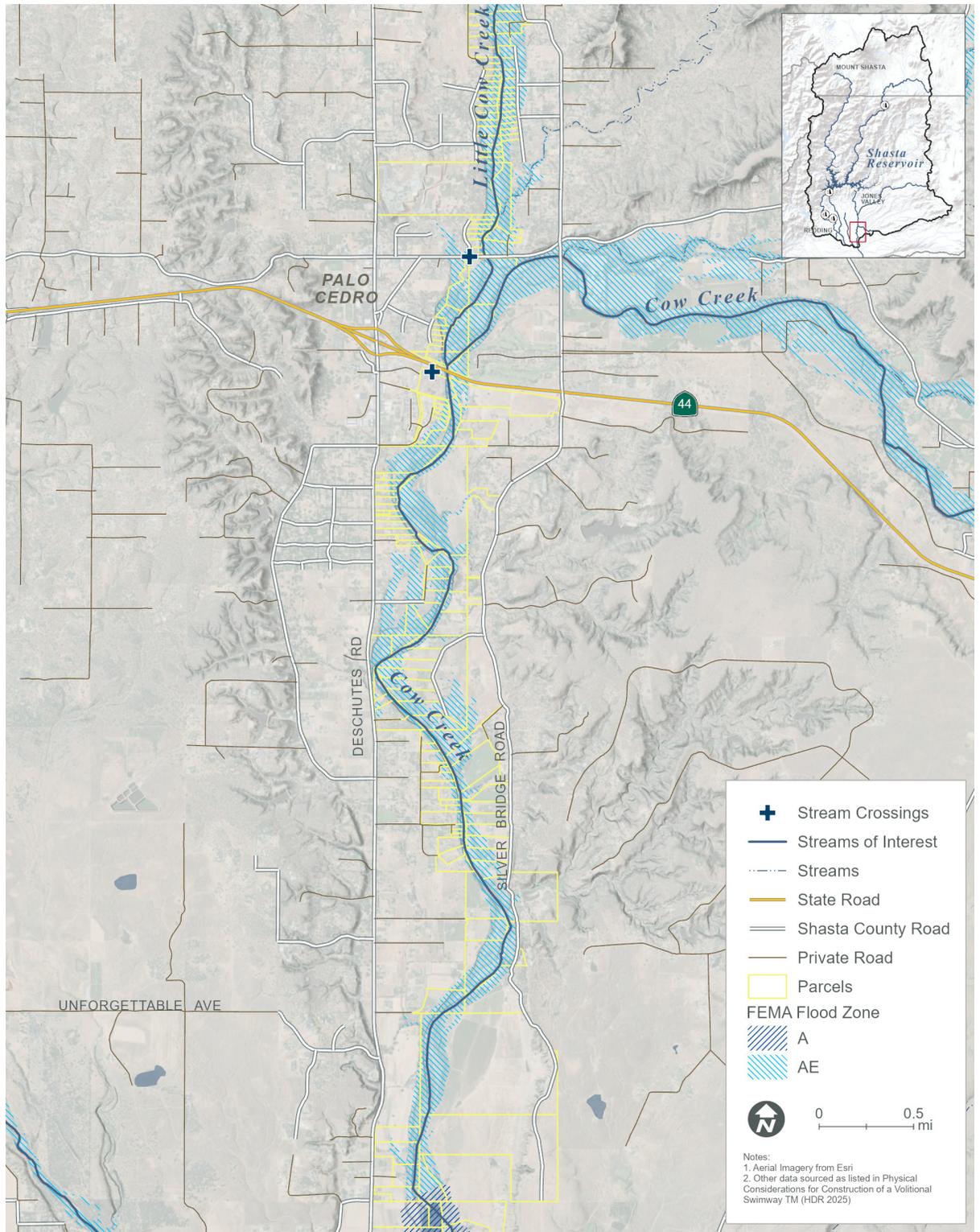
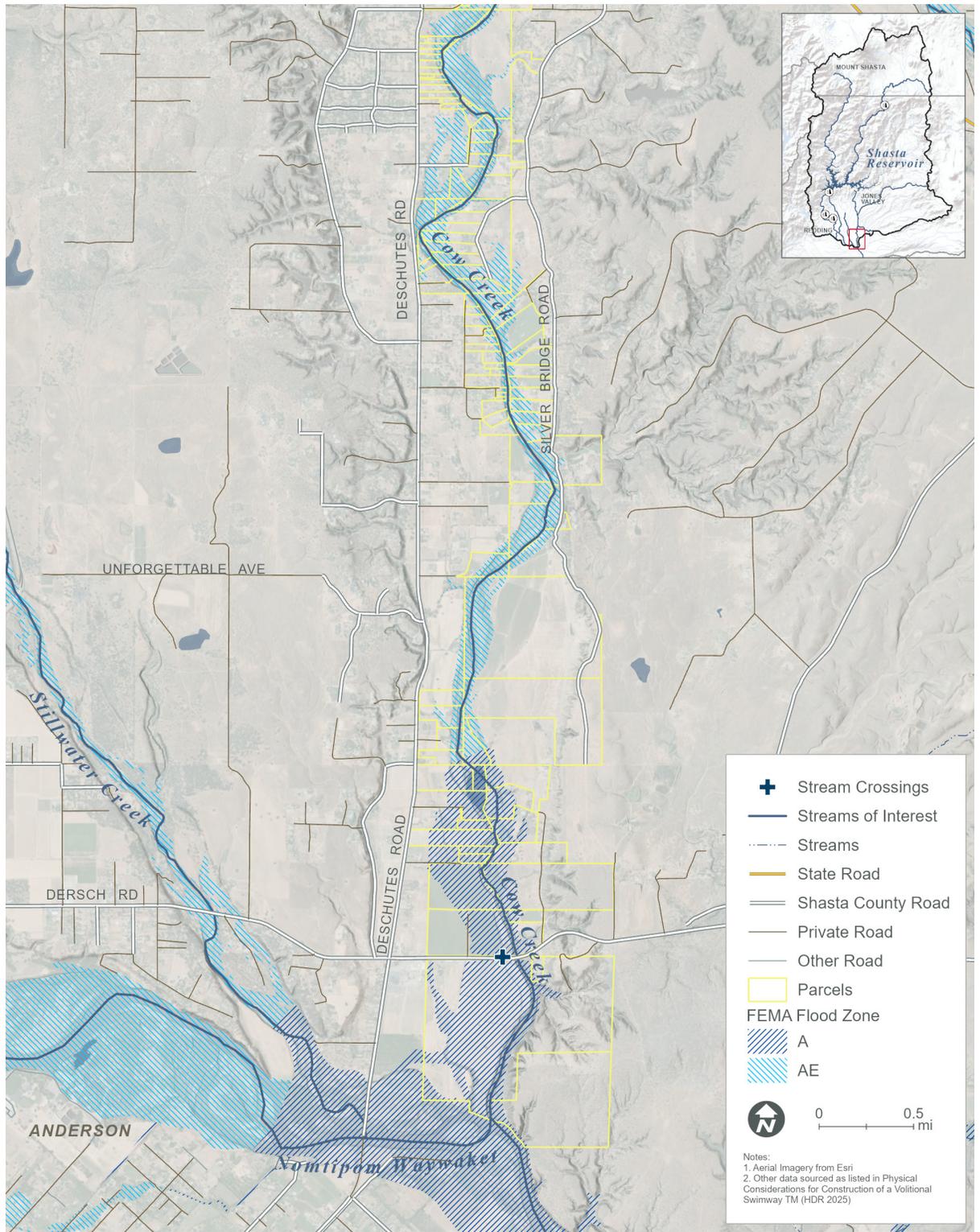


Figure 7
Existing Physical Data (Cow Creek, south)



2.2 Additional Data Collected

Additional data not used in the LFA is summarized in Sections 2.2.1 and 2.2.2 from other documents prepared for the Project including existing temperature logger data and water infrastructure, barriers, and water rights.

2.2.1 *Existing Temperature Logger Data*

Research was conducted to assemble existing water temperature data from the Winnemem Waywaket, Dry Creek, Little Cow Creek, and Cow Creek. Existing data is described in Section 2.1 of the *Temperature Data Collection Study* (Appendix I of the Background Compendium). Please see that document for information on existing temperature in the Study Area. This data will be used for future analyses.

2.2.2 *Water Infrastructure, Barriers, and Water Rights*

Existing information has been compiled and is documented in the *Water Infrastructure, Barriers, and Water Rights Data* (Appendix G of the Background Compendium). Please see that document for information regarding water infrastructure, barriers, and water rights in the Study Area. This data will be used for future analyses.

3 Limiting Factors on Construction and Operation of Fish Passage Facilities

At this stage of the Project, the exact size, type, and location of potential fish passage facilities that will be considered for design are unknown. The intent of the LFA is to identify site-specific challenges for the construction and operation of a future fish passage facility and to provide an overall ranking of the parcels along the study streams to be considered in future co-manager decisions when recommending facility location and type.

The LFA ranks parcels based on key considerations common to all types of fish passage facilities. The factors utilize the existing data gathered and summarized in Section 2 to inform the evaluation, and their importance in siting of fish passage facilities is further explained in Section 3.1.

3.1 Limiting Factors

Each parcel along the study streams were evaluated based upon the following factors:

1. **Access:** The Access factor is intended to identify parcels that have either existing stream access, road access, or both. Fish passage facilities require both stream access and road access for everyday function and ongoing maintenance. Existing water crossings provide the simplest stream and parcel access, while improved or unimproved roadways leading to the OHW line may also serve as important features. Furthermore, improved or unimproved roadways leading to the potential fish passage facility are crucial, especially in the more remote and mountainous areas within the Study Area to avoid significant and expensive road construction. Parcels that contain an existing water crossing or roadway receive a higher score, while parcels without existing stream crossings or roadways receive a lower score.
2. **Power Availability:** The Power Availability factor is intended to identify parcels that have existing electrical service. Electrical service is the most critical need for a future fish passage facility to operate and maintain the facility. Parcels that are already serviced by electrical power receive a higher score, while parcels without existing power nearby receive a lower score.
3. **Parcel Type:** The Parcel Type factor is intended to identify the ownership and whether a parcel had been previously developed for each of the parcels along the study streams. The parcels along the study streams vary between privately or publicly owned, and developed or undeveloped. The state of ownership or development affects the difficulty of acquiring easements or property. Parcels that are publicly owned and undeveloped receive a higher score, while parcels that are privately owned and developed receive a lower score.
4. **Parcel Size:** The Parcel Size factor is intended to identify the relative size of each of the parcels. Depending on the selected facility, a future fish passage facility may require purchase of only one large parcel (approximately three acres minimum), or could necessitate the purchase of

several smaller parcels (less than three acres), increasing Project costs and coordination needs. Larger parcels receive a higher score, while smaller parcels receive a lower score.

5. Federal Emergency Management Agency (FEMA) Flood Zone: depending on the FEMA flood zone, additional permitting effort may be needed for construction of facilities. Extra cost, coordination, or effort may be associated with properties that are adjacent to a stream channel designated as a SFHA. Parcels along a stream denoted as Zone X (unshaded) or Zone D receive a higher score, while parcels along a stream denoted as Zone A or AE receive a lower score.

Each limiting factor is assigned a score of 0 to 5 for each parcel, with 25 points being the maximum score a parcel may be given. Each factor was weighted evenly. A higher score is preferable and is indicative of less limitations for construction and operation of a future fish passage facility. See Table 1 for further details of the scoring system used to evaluate each of the 455 parcels along the study streams.

Table 1
Limiting Factors and Scoring

Rate Scale	Access	Power Availability	Parcel Type	Parcel Size	FEMA Flood Zone
5	A water crossing exists, or a maintained (paved) roadway exists that leads to the existing OHW line; or there is a water crossing located on an adjacent right-of-way parcel	A commercial or industrial building exists on the site which most likely has 3-phase power	The parcel is publicly owned and without development	The parcel is 3 acres or greater	The parcel is Zone X (unshaded) – area of minimal flood hazard. No additional permitting required.
4	A water crossing or maintained roadway exists that is within 1/4 mile of the site; or a maintained roadway exists that leads to the parcel	A residential building exists on the site which most likely has single phase power	The parcel is publicly owned and is developed	The parcel is between 2 and 3 acres	N/A
3	An unimproved road within the parcel (dirt, or gravel) exists leading to the OHW line	There are no existing buildings at the site, but there are existing parcels with buildings or electrical service lines (excluding transmission lines) within a 1/2-mile measured along roadways	The parcel is owned by a limited liability company or corporation and without development	The parcel is between 1.5 and 2 acres	The parcel is Zone D – area of possible but undetermined flood hazards. No additional permitting required.
2	An unimproved road (dirt, driveway, or gravel) roadway exists on the parcel but does not lead to the OHW line	There are no existing buildings at the site but there are existing electrical service lines (excluding transmission lines) within 1 mile measured along unimproved or improved roadways	The parcel is owned by a limited liability company or corporation and is developed	The parcel is between 1.0 and 1.5 acres	N/A
1	Improved and/or unimproved roadways or crossings are within 1 mile of the site	There are no existing buildings at the site but there are existing electrical service lines (excluding transmission lines) within 5 miles measured along unimproved or improved roadways	The parcel is owned by a private landowner or by a trust and without development	The parcel is between 0.5 and 1.0 acre	N/A
0	Roadways or crossings are greater than 1 mile from the site	Electrical service lines (excluding transmission lines) are greater than 5 miles from the site measured along unimproved or improved roadways	The parcel is owned by a private landowner or by a trust and is developed	The parcel is less than 0.5 acre	The parcel is Zone A or AE – SFHA. Additional permitting required.

3.2 Results of Limiting Factors Analysis

Table 2 provides a summary of the results of the LFA for all 455 parcels. Out of the possible 25 points, the maximum score achieved by any parcel was 23 points, and the minimum score was 9 points.

Table 2
Limiting Factors Analysis Results

Score (Points)	Rating	Number of Parcels
19 – 25	Optimal	14
16 – 18	Good	92
13 – 15	Fair	235
0 – 12	Poor	114

Fourteen parcels received a score of Optimal and achieved between 19 and 25 points. See Figure 8 through Figure 13 for the locations of each parcel rated Optimal, Good, Fair, and Poor. Attachment B includes the full results of the LFA.

Figure 8
Limiting Factors Analysis (Winnemem Waywaket, north)

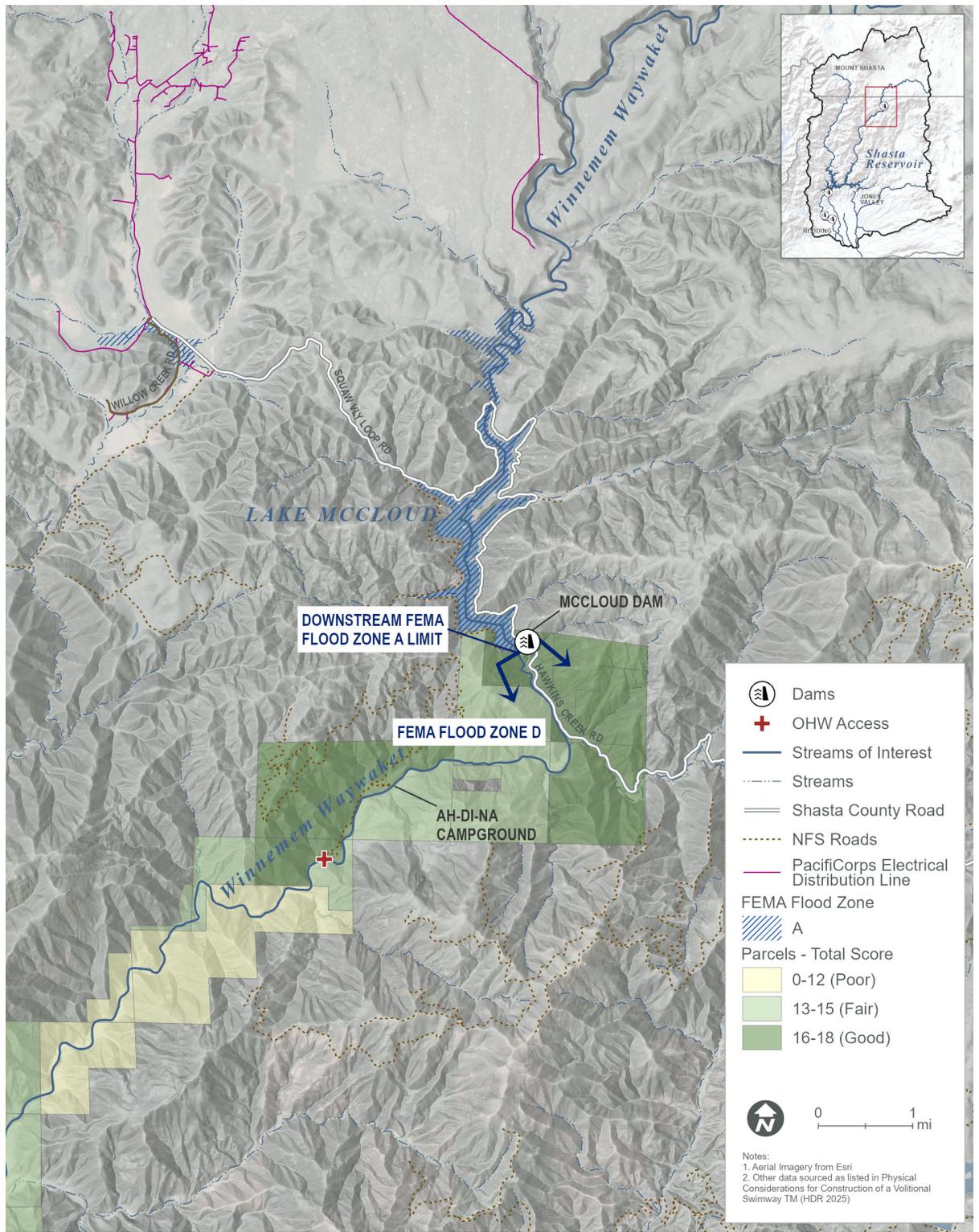


Figure 9
Limiting Factors Analysis (Winnemem Waywaket, south)

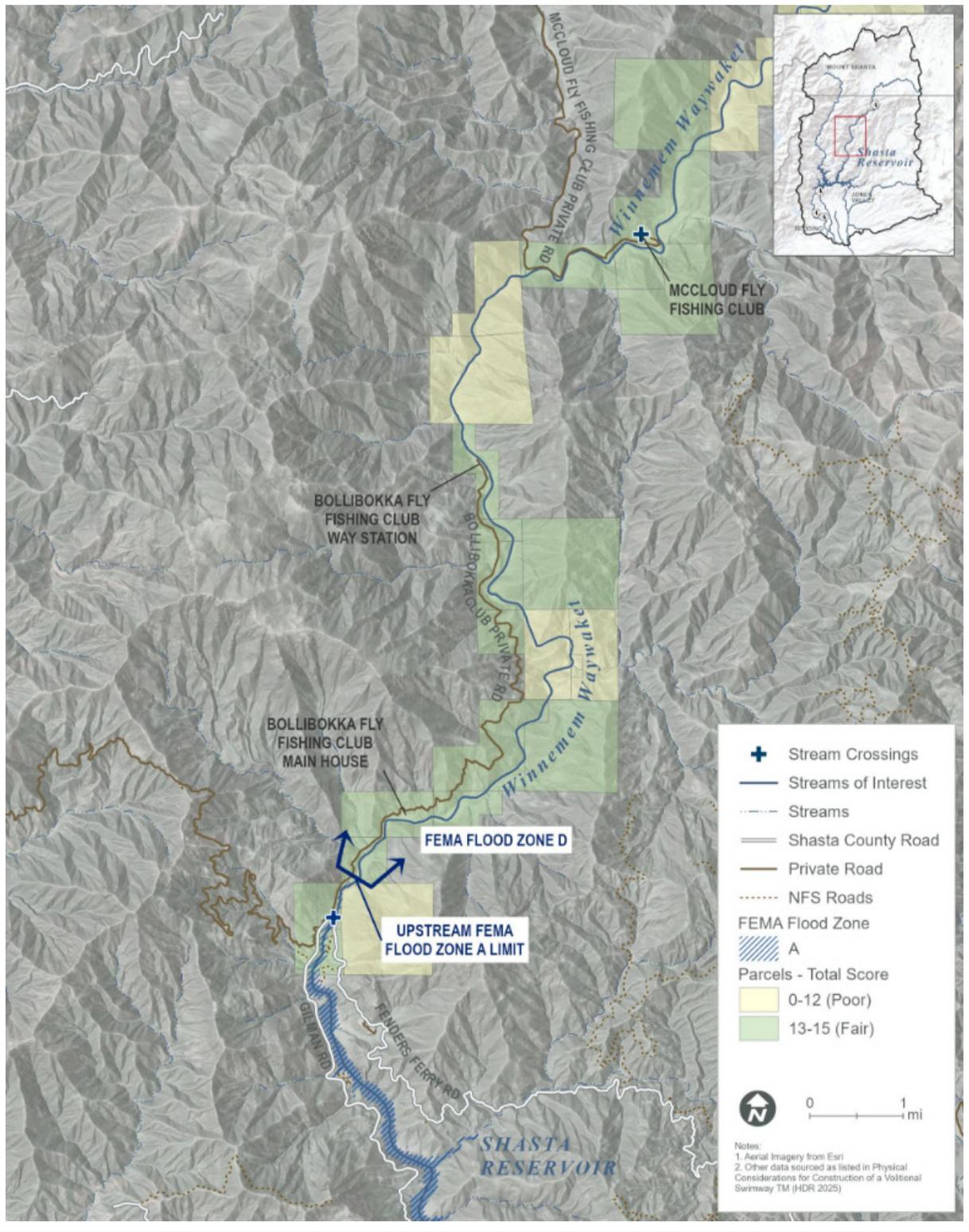


Figure 10
Limiting Factors Analysis (Dry Creek, north)

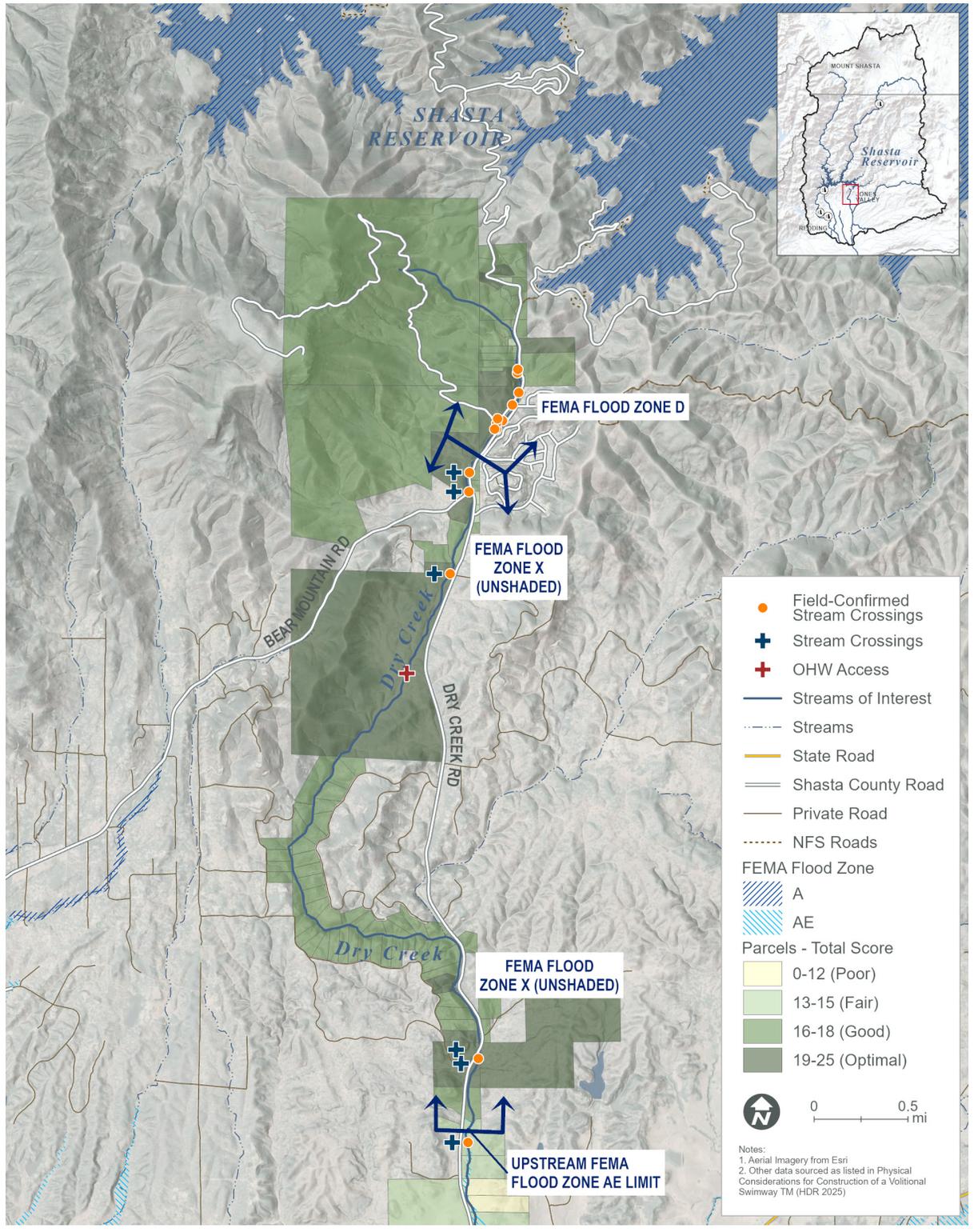


Figure 11
Limiting Factors Analysis (Dry Creek, south and Little Cow Creek, north)

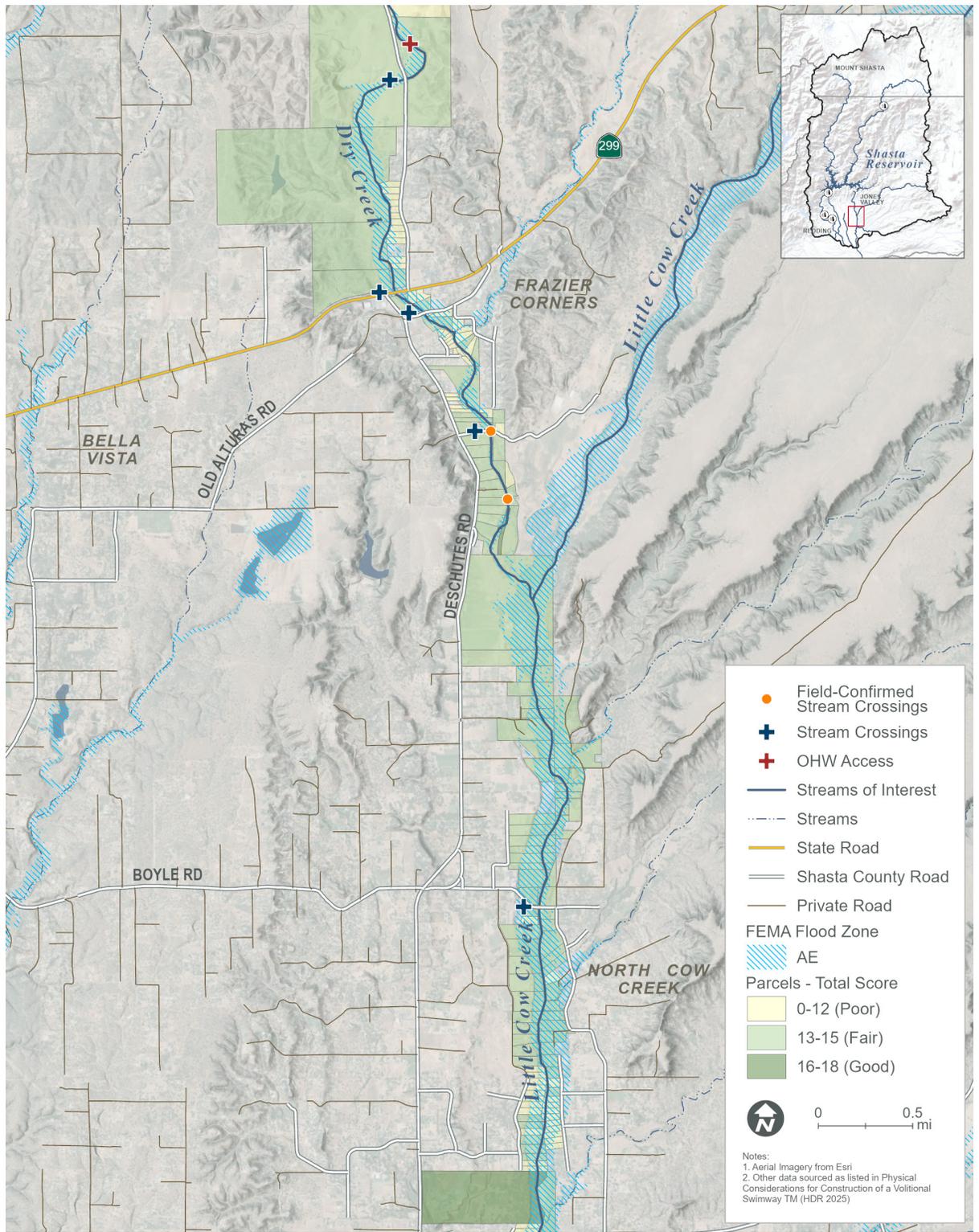


Figure 12
Limiting Factors Analysis (Little Cow Creek, south and Cow Creek, north)

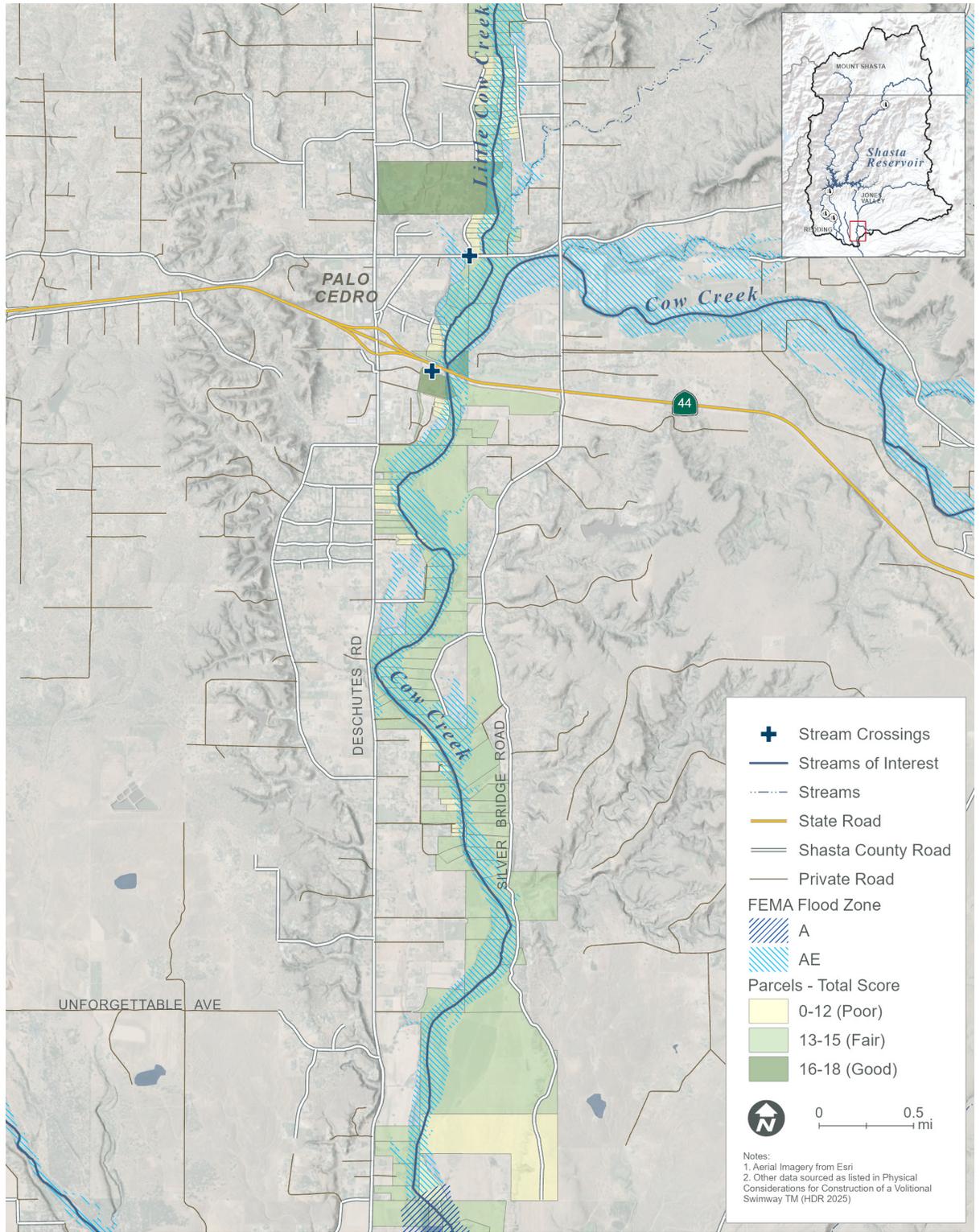
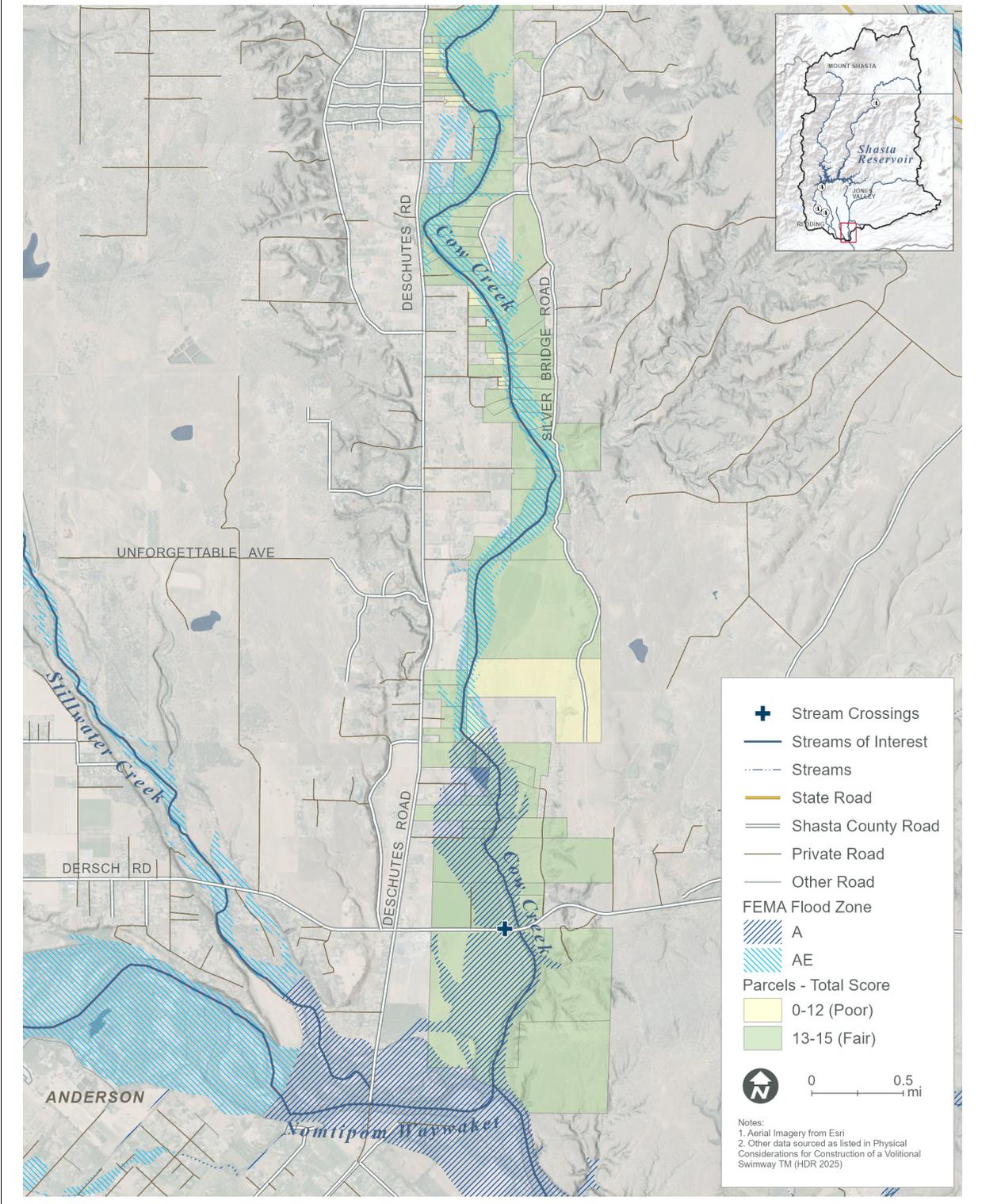


Figure 13
Limiting Factors Analysis (Cow Creek, south)



Overall, the 57 parcels located along the Winnemem Waywaket score high in the Parcel Size and FEMA Flood Zone categories; each parcel is large enough to accommodate a fish passage facility without additional property purchase and the flood zone classification (Zone D) indicates that floodplain development permits will not be required for construction. However, the same parcels score poorly in the Power Availability and Access categories. The closest existing known local electrical service is supplied by PacifiCorp to the City of Mount Shasta and is a minimum of 5 miles away from these parcels. It is assumed that electrical service is provided to McCloud Dam and that parcels nearby may be able to utilize this power source, but power availability at this location is a data gap at this time. Access to the river and existing roadways on the parcels is minimal; the private roads of Bollibokka and McCloud River Fishing Club provide road access to 12 parcels, while forest service roads provide access to three parcels near the Ah-Di-Na Campground and five parcels along the route to McCloud Dam. No other parcels along the river have improved or unimproved roadways. The parcels score moderately in the Property Type category since most parcels are privately owned and undeveloped.

The remaining 398 parcels located along Cow Creek, Little Cow Creek, and Dry Creek score well in the Access and Power Availability categories. There are only 23 known water crossings; however, main roads lead to nearly every parcel, providing easy accessibility to a potential facility. Although local electrical service distribution line data was not obtained for this area, most parcels contain residential development, and it is assumed that these parcels already possess local electrical service. Consequently, nearly every parcel in this area scores well in the Power Availability category. Conversely, due to the amount of private ownership and existing parcel development along these streams, the parcels generally score poorly in the Parcel Type category. The parcels score poorly to moderately in the FEMA Flood Zone category because most are located in an SFHA (Zone A or AE), indicating the need to obtain a floodplain development permit to construct a fish passage facility. Also, the parcels score poorly to moderately for Parcel Size as many of the parcels are residential and small, where locating a facility would require that multiple, adjacent parcels be purchased.

Though the required types and locations of potential future fish passage facilities are unknown at this stage of the Project, several likely areas were identified and are discussed in more detail in the following sections.

3.2.1 Bollibokka Fly Fishing Club

The area near the private Bollibokka Fly Fishing Club is one of the most likely areas for a future fish passage facility. Throughout the Winnemem Waywaket downstream of Ah-Di-Na Campground, there are no access roads along the river other than private roads to the McCloud Fly Fishing Club and Bollibokka Fly Fishing Club. The Bollibokka Fly Fishing Club road stretches approximately 6.5 miles from the McCloud Day Bridge to the main Bollibokka fly fishing facility (Main House), before terminating at a second Bollibokka property (Way Station) further upstream. The road travels

through nine parcels that range from scores of 11 points to 13 points. The highest scoring parcels have moderate to high scores in most categories except Power Availability and Parcel Type; at this stage it is assumed that the parcels containing the Main House and the Way Station do not have electrical power access and only have a generator. The properties score low in the Parcel Type category because the parcels are privately owned. Therefore, the main challenges with facility siting in this area is likely coordination with property owners and power availability.

3.2.2 Head of Shasta Reservoir

Near the head of Shasta Reservoir, co-managers are performing ongoing work involving pilot scale collection facilities. This location would be an optimal place for a future downstream fish passage collection site for the Project due to the work already occurring in this area and because it is owned by a public agency as part of an established National Recreation Area. There are four parcels in this location owned by the public which score 13, 15, 18, and 19 in the analysis. All parcels score well in the Parcel Size, Parcel Type, and FEMA Flood Zone categories due to their largely undeveloped nature and their location near the head of the reservoir. The two parcels scoring 18 and 19 points are near the McCloud Bridge and score well in the Access category because of their vicinity to the water crossing and the presence of maintained roadways, which are not present on the other two parcels. All four parcels score poorly in the Power Availability category; the main challenge with facility siting in this area will be electrical service.

3.2.3 Upstream End of Dry Creek

A ridge line just east of Bear Mountain is the upstream end of potential volitional fish passage within Dry Creek. Near this location, a facility will be needed to link fish passage from upper Dry Creek to the Winnemem Waywaket. Parcel scoring in this area ranges from 14 to 21 points. Most parcels score moderate to high in all categories but score poorly in either the Parcel Type or the Power Availability category; some parcels have private owners and are developed, causing a high Power Availability score with a low Parcel Type score, and others have public owners as part of the Shasta Recreational Area and are undeveloped, scoring high in the Parcel Type and low in the Power Availability category. The area studied by FEMA ends in the downstream Dry Creek stream reach, so the Flood Zone identified for all upstream Dry Creek parcels is Zone X (unshaded) which could result in a simpler permitting path for a facility as no floodplain development permit would be necessary.

4 Summary of Findings

This document summarizes the readily available information on topographic data, transportation corridors, electrical service, property ownership and use, FEMA flood zone data, and stream access points along the potential volitional swimway route. The data was used in an LFA to provide a high-level overview of the challenges and opportunities related to siting of potential fish passage facilities within the Study Area. Data gaps identified as part of the data summary are evaluated in Section 4.1.

4.1 Data Gaps

Channel bathymetry: No accurate bathymetric data was identified within the Winnemem Waywaket, Cow Creek, or Little Cow Creek through inspection of the USGS LiDAR dataset (OCM Partners 2024). Throughout some of the upstream reaches of Dry Creek in the dataset, channel bathymetry data was collected because the channel was presumed dry at the time of collection, but further downstream in Dry Creek, accurate data was not collected (OCM Partners 2024). Examination of existing data informed Study Area LiDAR data collection efforts within the Winnemem Waywaket undertaken by NV5 in 2024 (NV5 2025). The dataset covers approximately 3,422 acres of waterways around Shasta Dam but failed to register bathymetry from depths greater than approximately 4 to 5 feet. Therefore, detailed channel bathymetry remains a data gap within the Winnemem Waywaket, Cow Creek, Little Cow Creek, and portions of Dry Creek. Additional data may be collected at later stages of design for the Project to help inform the existing water crossings, points of access, and potential facility sites along the streams. In addition, the topography along the OHW line of the study streams must be further researched and evaluated at later stages of design because it may not be feasible to place a fish passage facility at certain locations if the terrain elevation is significantly above the OHW line and does not allow for access.

Electrical service: Other companies such as PG&E provide local electrical service to the area other than those that provided detailed information in Section 2.1.3. Though it is known PG&E provides electrical service for developed residential parcels along Cow Creek, Little Cow Creek, and Dry Creek, additional information about the extent and level of service of the electricity will need to be determined during later stages of design. Also, it is unknown if electrical service is currently provided to Ah-Di-Na Campground, McCloud Bridge Day Use Area, McCloud Fly Fishing Club, and Bollibokka Fly Fishing Club, and it must be determined if and how these locations are supplied with electrical service during future steps of the Project. During this analysis, it was assumed that the Ah-Di-Na Campground, McCloud Bridge Day Use Area, and the two private fly fishing clubs use a generator and are not supplied with power.

Road condition: The drivability and level of service of many of the private roads and forest service roads along the Winnemem Waywaket (particularly the Bollibokka Fly Fishing Club and McCloud Fly Fishing Club private roads) must be further investigated to determine if they are in sufficient

condition so as to be used by large trucks for access to a new facility. If in disrepair or at a poor level of service, it may not be possible to use these existing roadways to maintain and operate a new facility without significant roadway improvements or rebuilding.

Additional permitting: Coordination efforts are required with the local floodplain administrator to determine floodplain development permitting needs for construction along each of the study streams. Although there are some sections of the stream channel designated as Zone D or as Zone X (unshaded), these areas may still require additional floodplain analysis such as a Letter of Map Revision according to the local floodplain administration's general practices. Later, as design is progressed, it is recommended to connect with the administrator to confirm floodplain development permitting requirements within each flood zone.

Additional information: Lastly, further research and development of alternatives is required to determine the type of facilities that may be needed for this Project. The current LFA provides a broad glimpse into optimal parcels for the construction and operation of potential fish passage facilities; at later Project steps, these facilities will be sited using a more detailed approach and evaluation with consideration to the differing needs and challenges associated with the type of facility.

5 References

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Attachment 1

Metadata Table

Table 1
Existing Data Sources

Element	Data set title [Station ID]	Source	Acquisition	Access Details	Location	Year of Collection / Most Recent Update
LiDAR	USGS Lidar Point Cloud CA_CarrHirzDeltaFires_2019_B19 10TEL0548245142	USGS (OCM Partners 2024)	Downloaded through USGS database on June 25, 2024 and July 10, 2024. USGS Lidar Point Cloud CA_CarrHirzDeltaFires_2019_B19 10TEL0558745187 - ScienceBase-Catalog	Publicly available, no constraint	See Table 5-2	2019
Electrical service	Electric Substation	California Energy Commission (CEC 2024)	Downloaded through CEC database on June 28, 2024 for purposes of this document. Live Representational State Transfer (REST) service used for ArcGIS Online basemap. California Electric Transmission Lines California Energy Commission GIS Open Data (arcgis.com)	Publicly available, no constraint	03_CEC_TransmissionLines.zip	2024
Electrical service	Pacific Power	PacifiCorp (PacifiCorp 2024)	Provided by PacifiCorp on August 9, 2024.	Data provided by PacifiCorp, cannot be redistributed without prior consent	01_PacificPower_GIS.zip	2024
Electrical service	Shasta Lake Electric Utility Service Territory	City of Shasta Lake (City of Shasta Lake 2024)	Provided by the City of Shasta Lake on August 12, 2024.	Data provided by City of Shasta Lake, cannot be redistributed without prior consent	09_ShastaLakeElectricalUtilityServiceTerritory.gdb.zip	2024
Electrical service	City of Redding Electrical Service	City of Redding (City of Redding 2024)	Provided by the City of Redding on November 5, 2024.	Data provided by City of Redding, cannot be redistributed without prior consent	08_CityOfReddingElectricalService.zip	2024
Roads	Shasta County Roads	Shasta County (Shasta County 2024)	Downloaded through Shasta County database on May 31, 2024. Layer: Roads (ID: 0) (shastacounty.gov)	Publicly available, no constraint	02_ShastaCounty_Roads.zip	2024
Roads	National Forest System Roads	USDA Forest Service (USDA Forest Service 2024)	Downloaded through USDA Forest Service on August 21, 2024 for purposes of this document. Live Representational State Transfer service used for ArcGIS Online basemap. USDA Forest Service FSGeodata Clearinghouse - Download National Datasets	Publicly available, no constraint	04_USFS_Roads.zip	2024
Parcel data	Parcel data	LOVELAND Technologies (LOVELAND Technologies 2024)	Downloaded through Regrid website on August 12, 2024; information sourced from LOVELAND Technologies which generates its data from Shasta County	Data provided by LOVELAND Technologies, cannot be redistributed without prior consent	05_ShastaCounty_ParcelInformation.gdb.zip	2024
Stream crossings and OHW access data	Stream Crossings and OHW Access	HDR (HDR 2024b)	Created in Google Earth using aerial imagery on September 5, 2024.	Data provided by HDR, cannot be redistributed without prior consent	06_WaterCrossings_Access.zip	2024
Field-confirmed stream crossings	Field-confirmed stream crossings	HDR (HDR 2024c)	Field investigations taking place on November 7 and 8, 2024.	Data provided by HDR, cannot be redistributed without prior consent	10_FieldConfirmedStreamCrossings.gdb.zip	2024
Bollibokka Fly Fishing Club Private Road and McCloud Fly Fishing Club Private Road	Bollibokka and McCloud Club private roads	HDR (HDR 2024a)	Created in Google Earth using aerial imagery on September 20, 2024.	Data provided by HDR, cannot be redistributed without prior consent	07_Bollibokka_McCloudClub_Private_Roads.kmz	2024

Table 2
List of LiDAR tiles used in data analysis (OCM Partners 2024)

10TEK0564744895	10TEL0563245030	10TEL0564045330	10TEL0573045487	10TEL0575245495	10TEL0577545510
10TEK0564744925	10TEL0563245037	10TEL0564045337	10TEL0573045495	10TEL0575245502	10TEL0577545517
10TEK0564744932	10TEL0563245060	10TEL0564745330	10TEL0573745487	10TEL0575245510	10TEL0577545525
10TEK0564744962	10TEL0563245067	10TEL0564745337	10TEL0573745495	10TEL0576045510	10TEL0578245502
10TEK0564744970	10TEL0563245322	10TEL0564745345	10TEL0574545487	10TEL0576045517	10TEL0578245510
10TEK0565544925	10TEL0563245330	10TEL0565545337	10TEL0574545495	10TEL0576745510	10TEL0578245517
10TEK0565544932	10TEL0564045060	10TEL0565545345	10TEL0574545502	10TEL0576745525	10TEL0578245525
10TEL0562545030	10TEL0564045067	10TEL0572245487	10TEL0574545510	10TEL0577545502	10TEL0578245532
10TEL0562545037	10TEL0564045322	10TEL0572245495			

Attachment 2

Limiting Factors Analysis Tables

Table 1
Summary of Limiting Factors Analysis

Score (Points)	Number of Parcels
25	0
24	0
23	1
22	1
21	0
20	1
19	11
18	74
17	6
16	12
15	20
14	43
13	172
12	47
11	31
10	23
9	13
8	0
7	0
6	0
5	0
4	0
3	0
2	0
1	0
0	0
Total	455